CLAIMS

What is claimed is:

1. A method for determining filter coefficients to form a filter to filter data of length N, wherein the filter coefficients are optimized to minimize an objective function that measures a predetermined quality of the signal data, the method comprising the steps of:

providing a number of coefficients, K, in the filter;

selecting a wavelet packet basis;

providing an objective function;

providing a first set of k/2 parameter values;

forming a data transform matrix as a function of wavelet packet basis and the k/2 parameter values;

calculating transformed data by multiplying the data transform matrix with the signal data;

calculating the value of the objective function based on the transformed data; and

finding the optimal set of values for the k/2 parameters.

2. The method of claim 1 wherein the step of finding the optimal set of values for the k/2 parameters includes:

determining if the value of the objective function satisfies a first criteria;

in the event that the value of the objective function satisfies the first criteria, setting the optimal set of the values of the k/2 parameters equal to the current value of the first set of k/2 parameters;

in the event that the value of the objective function does not satisfy the first criteria,

calculating the Jacobian of the data transform matrix based on the data and the current values of the k/2 parameters;

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TEL. (617) 542-2290
FAX. (617) 451-0313

calculating the gradient of the calculated objective function with respect to the transformed input data;

multiplying the Jacobian with the gradient of the calculated objective function with respect to the transformed input data to form the gradient of the parameters;

determining if the gradient of the parameters satisfies a second threshold value;

in the event that the gradient of the parameters satisfies the second criteria, calculating the optimal filter coefficients based on the current values of the k/2 parameters;

in the event that gradient does not satisfy the second threshold value, forming a new set of k/2 parameter values by updating the value of the current value of the k/2 parameters delta value;

returning to the forming a data transform matrix step and re-execute the intervening steps.

3. The method of claim 1 wherein the step of selecting a wavelet packet basis includes selecting an optimal wavelet basis.

4. The method of claim 3 wherein the optimal wavelet basis is an orthonormal basis.

5. The method of claim 4 wherein the optimal orthonormal basis is selected from a wavelet packet library.

6. The method of claim 5 wherein the optimal orthonormal basis selected from a wavelet packet library is selected to minimize a predetermined cost function.

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7. The method of claim 6 wherein the cost function is an entropy function of the wavelet packet basis applied to the input data sequence.

8. The method of claim 7 wherein the entropy function is equal to $-\sum_n p_n \log_2 p_n$.

9. The method of claim 1 wherein the step of providing a first set of k/2 parameters includes providing k/2 lattice filter angles.

10. The method of claim 9 wherein the reparameterized basis is a function of at least one trigonometric function.

11. The method of claim 1 wherein the data transform matrix is of the form $C = E_Q R_Q(\theta_1) S_Q R_Q(\theta_2) \ldots S_Q R_Q(\theta_1) \ldots E_1 R_1(\theta_1) S_1 R_1(\theta_2) \ldots S_1 R_1(\theta_1)$ with $Q \leq \left[\log_2\left(\frac{M+1}{N+1}\right)\right]$.

12. The method of claim 2 wherein the form of the Jacobian matrix of the data transform matrix is of the form

$$ER_Q(\theta_1)S_Q \ldots \partial_j R_Q(\theta_j) \ldots S_1 R_1(\theta_K) + ER_Q(\theta_1)S_Q \ldots \partial_j R_{Q-1}(\theta_j) \ldots S_1 R_1(\theta_K) +$$
$$\ldots . ER_Q(\theta_1)S_Q \ldots \partial_j R_j(\theta_j) \ldots S_1 R_1(\theta_K)$$

13. The method of claim 12 wherein the form of the Jacobian matrix of the data transform matrix is of the form

$$ER_Q(\theta_1)S_Q \ldots R_Q\left(\theta_j + \frac{\pi}{2}\right) \ldots S_1 R_1(\theta_K) + ER_Q(\theta_1)S_Q \ldots R_{Q-1}\left(\theta_j + \frac{\pi}{2}\right) \ldots S_1 R_1(\theta_K) +$$
$$ER_Q(\theta_1)S_Q \ldots R_Q\left(\theta_j + \frac{\pi}{2}\right) \ldots S_1 R_1(\theta_K).$$

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14. The method of claim 13 wherein the Jacobian matrix of the data transform matrix is of the form

$$ER_Q(\theta_1)S_Q...D_QR_Q(\theta_j)..S_1R_1(\theta_1)+ER_Q(\theta_1)S_Q...D_{Q-1}R_{Q-1}(\theta_j)..S_1R_1(\theta_1)+$$
$$ER_Q(\theta_1)S_Q...D_1R_1(\theta_j)..S_1R_1(\theta_k)$$

15. The method of claim 1 wherein step (d)providing a first set of k/2 parameter values includes providing random values for the first set of k/2 parameters.

16. The method of claim 1 wherein the step of providing a first set of k/2 parameter values includes using a priori information.

17. The method of claim 1 wherein the step of providing a first set of k/2 parameter values includes the steps of:

selecting a mother wavelet;

selecting a set of K coefficients corresponding to the mother wavelet; and

computing the k/2 parameters that correspond to the mother wavelet in a lattice decomposition.

18. The method of claim 1 wherein the step of providing a first set of k/2 parameter values includes the steps of:

selecting a mother wavelet;

selecting a set of K coefficients corresponding to the mother wavelet; and

providing k/2 predetermined parameters that correspond to the mother wavelet in a lattice decomposition.

19. The method of claim 1 wherein the step of providing a first set of k/2 parameter values includes providing the first set of k/2 parameter values that satisfy a zero mean filter criteria.

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20. The method of claim 19 wherein the zero mean filter criteria is $\sum_{j=1}^{k}\theta_j = \frac{\pi}{4}$.

21. The method of claim 20 wherein the step of finding the optimal set of values for the k/2 parameters includes:

defining the objective function as:

$$\Phi(\theta_1,\ldots,\theta_{k-1}) = \phi\left(\theta_1,\ldots,\frac{\pi}{4}-\sum_{j=1}^{k-1}\theta_j\right);$$

providing the gradient of the objective function with respect to the k/2 parameters as:

$$\nabla\Phi(\theta_1,\ldots,\theta_{k-1}) = \begin{bmatrix} 1 & \ldots & 0 & -1 \\ \vdots & \ddots & \vdots & \vdots \\ 0 & \ldots & 1 & -1 \end{bmatrix} \nabla\phi\left(\theta_1,\ldots,\frac{\pi}{4}-\sum_{j=1}^{k-1}\theta_j\right);$$

setting the gradient to a threshold value; and

solving the gradient for a set of k/2 parameters that satisfy the gradient equation.

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FAX. (617) 451-0313